Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh

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Chapter 3
DSM2 Version 8.1 Recalibration

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3.1 Introduction

Modifications to the DSM2 program source code that improve channel geometry representation, presented at a DSM2 Users Group meeting (Liu & Ateljevich, 2011 Oct) and discussed in Chapter 2 of this Report (Liu, Ateljevich, & Sandhu, 2012), affects results both in DSM2-Hydro and DSM2-Qual. The model has been recalibrated by adjusting Manning's coefficient values in DSM2-Hydro. The recalibrated Hydro results (flow and stage) are very close to the Bay Delta Conservation Plan (BDCP) 2009 Calibration results (CH2M Hill, 2009 Oct), although there are significant changes in Manning's coefficient values. Stations for hydro calibration are shown in Figure 3-1. Qual was recalibrated in 2011 after we made changes to improve DSM2-Qual model convergence (Liu & Sandhu, 2011 Aug). Using the recently recalibrated Hydro, we reran the Qual module to check the impacts of the Hydro source code changes and the hydro recalibration on EC results. The electrical conductivity (EC) results are compared with field data and also the 2009 BDCP Calibration results.

3.2 Hydro Recalibration Results

This recalibration is based on the 2009 BDCP Calibration grid (CH2M Hill, 2009 Oct). The Hydro calibration period was from 10/1/2000 to 10/1/2002 and validation period from 10/1/2006 to 10/1/2008. Only Manning's coefficients were adjusted for this brief recalibration. All other model setup and boundary conditions were the same as in the 2009 BDCP Calibration.

The model was primarily calibrated to match observed flows. Modeled stage was also compared to observed stage. The calibration metric is composed of 4 figures for each station:

- **Timeseries comparison of tidally filtered daily-averaged flow.** This plot compares modeled and observed tidally averaged flow, or net flow. Net flow is critical for flow distribution and for salt transport.
- **Linear regression analysis of tidally filtered daily-averaged flow.** This scatterplot with a linear regression trend line shows statistically the comparison of the simulated vs. observed daily averaged flow. R^2 value gives information about the goodness of fit of the model. The trend line shows over- or under-estimating of the model.
- **Timeseries comparison of instantaneous flow.** This plot compares modeled and observed instantaneous flow. We show only 5 days in order to be able to see the tidal process and comparison clearly.
- **Timeseries comparison of instantaneous stage.** This plot compares modeled and observed instantaneous stage for the same period of the instantaneous flow plot.

Because overall the calibrated flow in 2009 BDCP Calibration matched observed data reasonably well, the 2009 calibration was used as a reference. Manning's n values were adjusted by groups. Sixteen adjustments/runs were made to reach the satisfactory result. Comparisons at key stations are plotted in Figure 3-2 to Figure 3-13: RSAC155, RSAC128, RSAC123, RSAC101, RSAN018, RSAN063, ROLD024, ROLD034, SLTRM004, CHDCC000, SLGEO009, and CHGRL009. Because we only adjusted Manning's n values in this brief recalibration, improvement of the calibration is slight. The recalibrated flow and stage results are very close to the 2009 calibration. Other changes in the model may be needed to further improve the calibration, e.g., improved estimates of Delta diversion and return flows and water quality, improved open area representations, better bathymetry, etc.

Due either to the bug fix or to a calibration process different than in the 2009 BDCP Calibration, Manning's n values changed significantly in some areas, as listed in Table 3-1 (for example, in Sutter Slough and Steamboat Slough, Manning's n changed from 0.024 to 0.031; Lower San Joaquin River channels 48 to 51 changed from 0.022 to 0.026; Montezuma Slough area changed from 0.018 to 0.021).

Table 3-1 Recalibrated Manning's Coefficient

GroupName	Channel Number	2009 Mini_Calibration	Recalibrated
SUTTER_SL	379--382	0.024	0.031
STEAMBOAT_SL	383--387	0.024	0.031
LOWER_SJR	48--53, 282--301	0.019--0.037, most 0.022	0.026
THREE MILE SL	307--310	0.033	0.032
FALSE_RIVER	276--279	0.027	0.025
DUTCH_SL	215, 260, 273--275	0.027	0.025
OLD_RIVER	81--124, 214--278	0.027	0.025
MONTEZUMA_SL	455--542	0.018	0.021

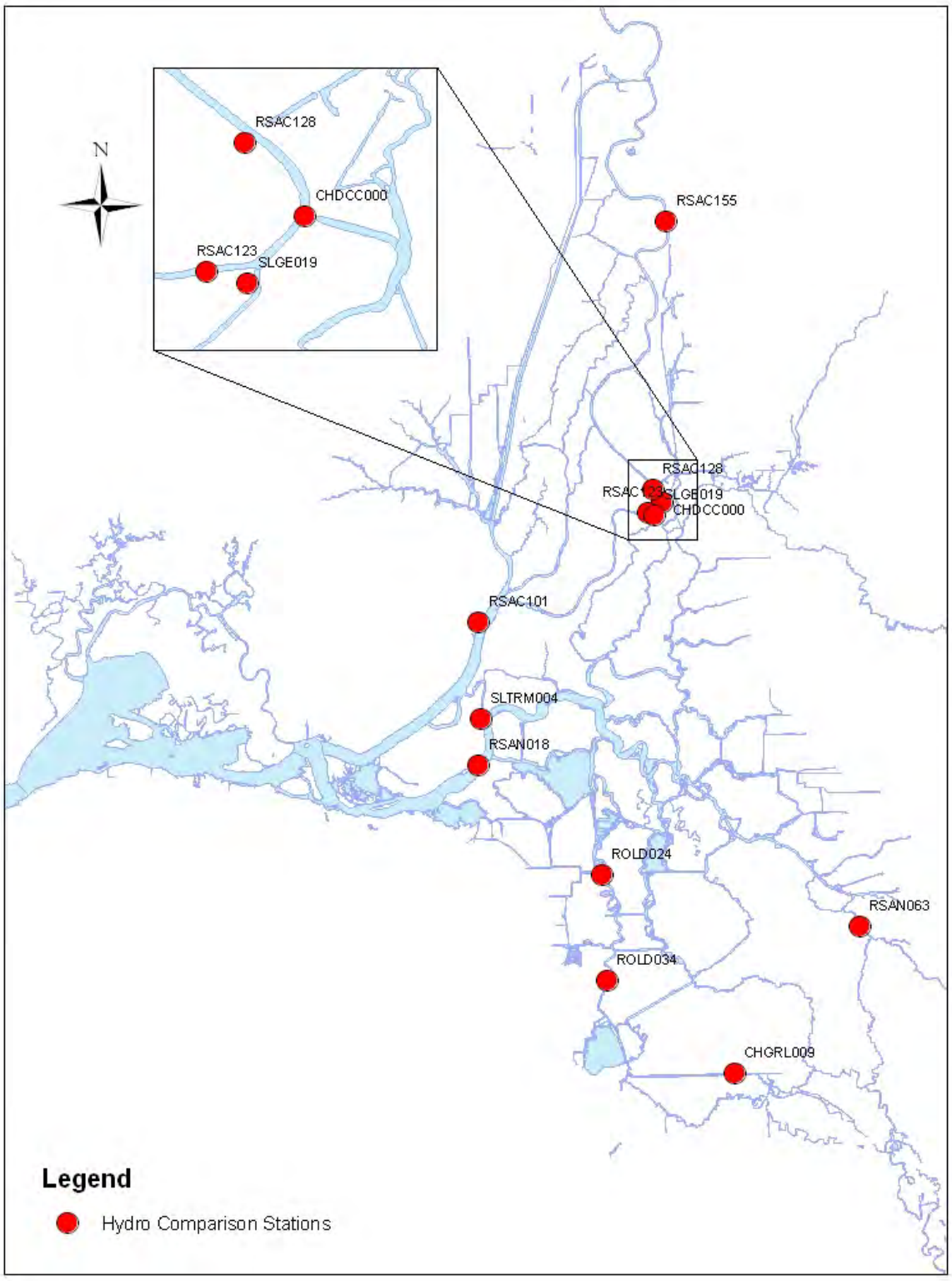


Figure 3-1 Stations for Hydro Calibration

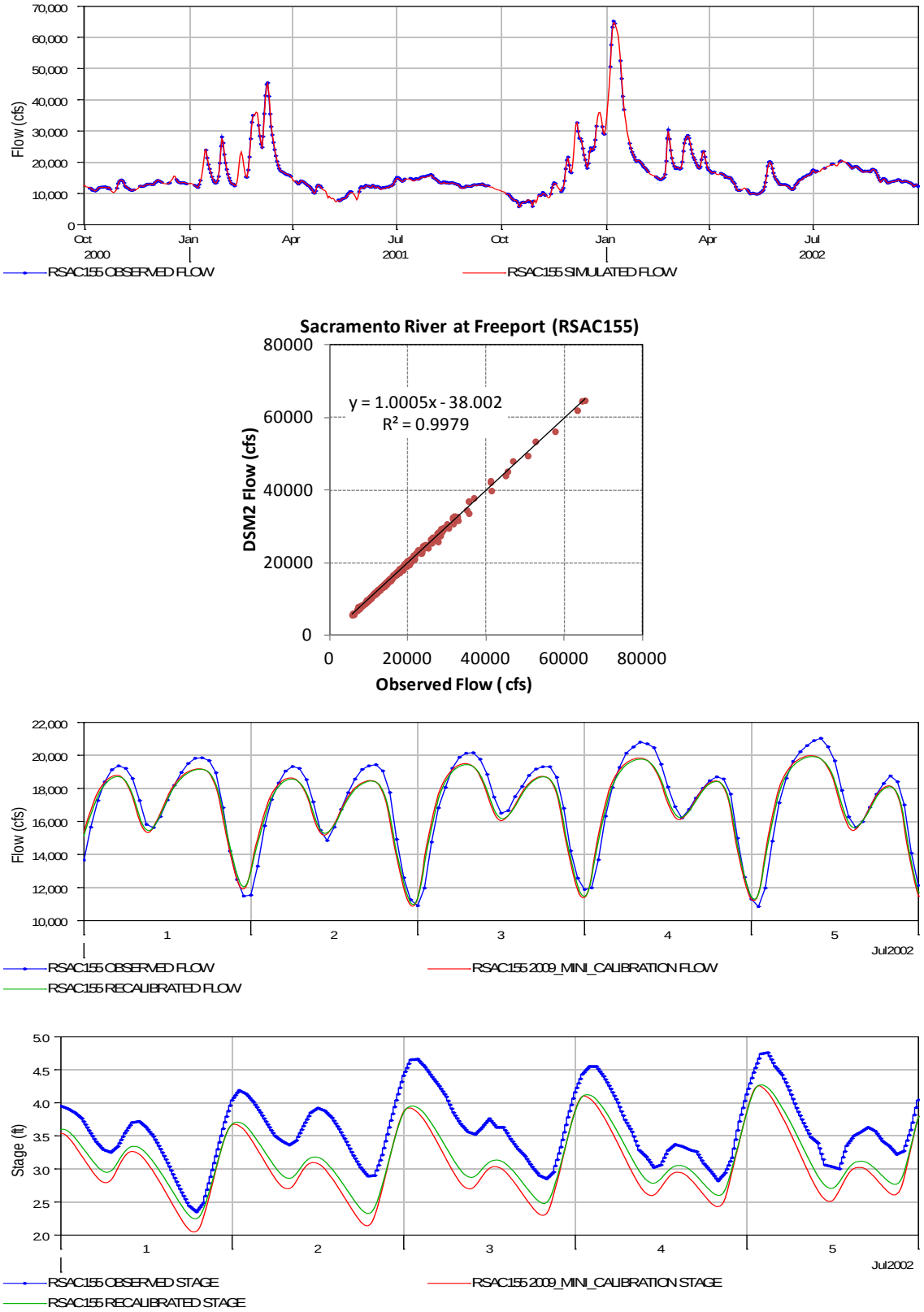


Figure 3-2 Hydro Calibration, Sacramento River at Freeport

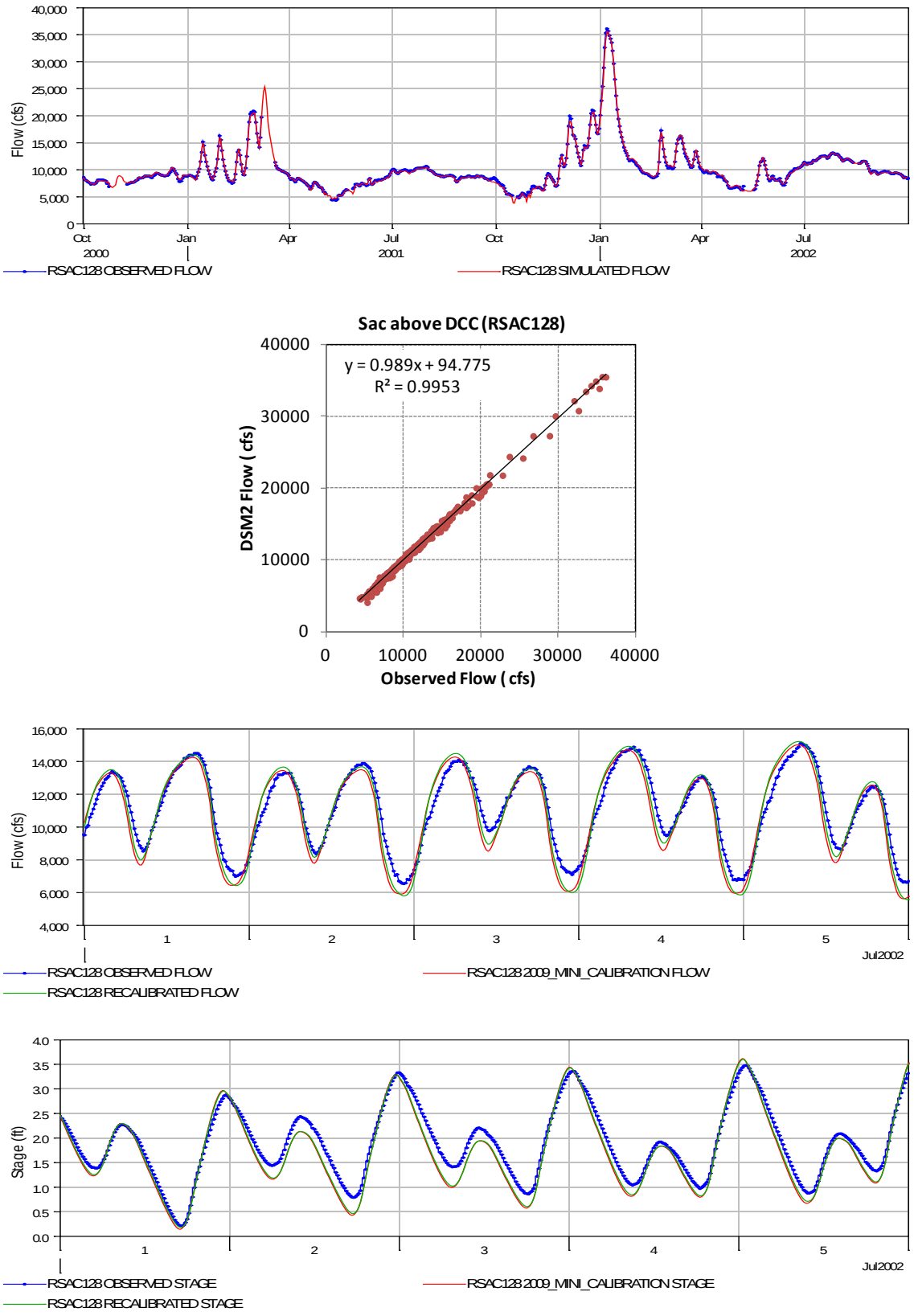


Figure 3-3 Hydro Calibration, Sacramento River above Delta Cross Channel

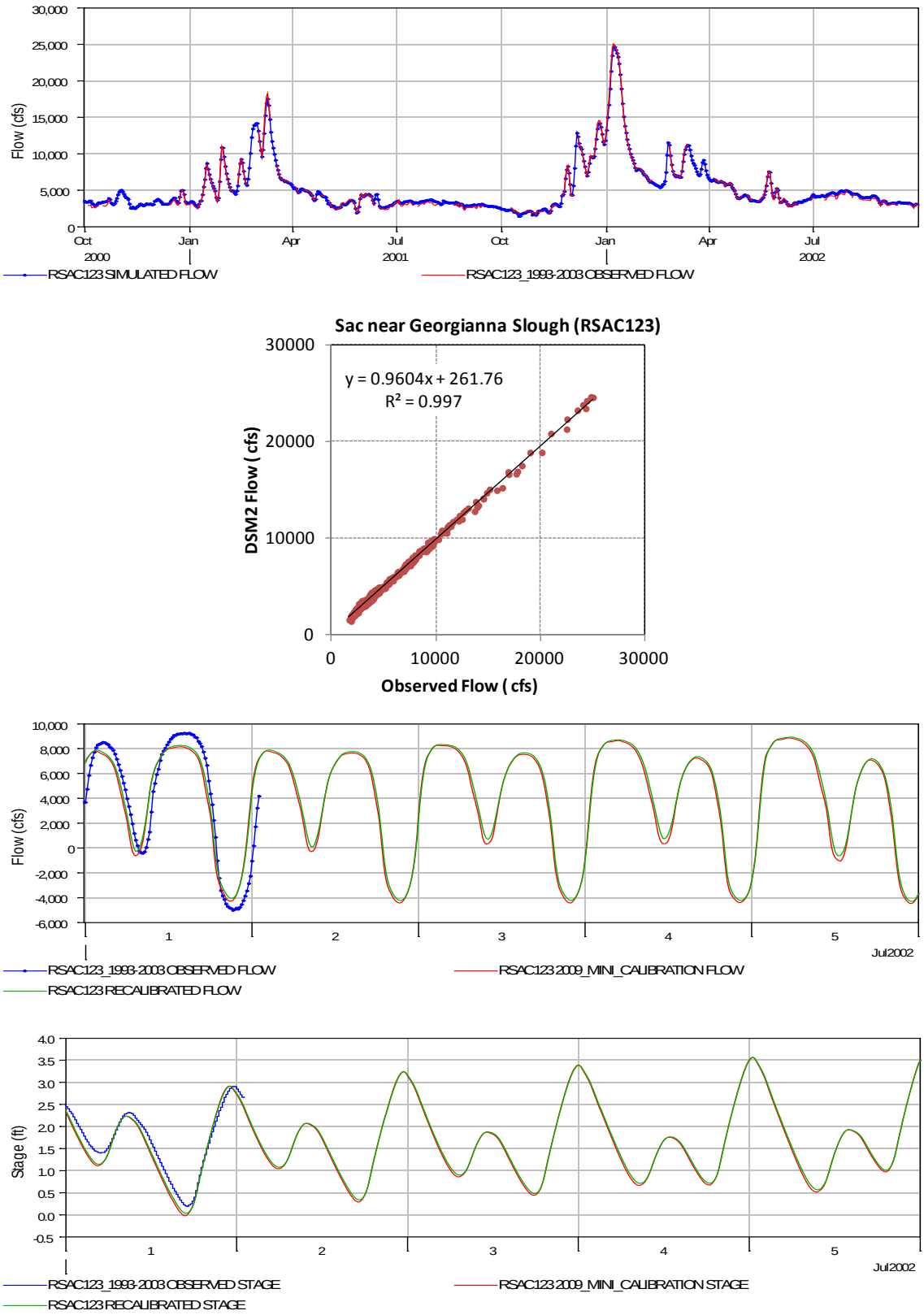


Figure 3-4 Hydro Calibration, Sacramento River downstream of Georgiana Slough

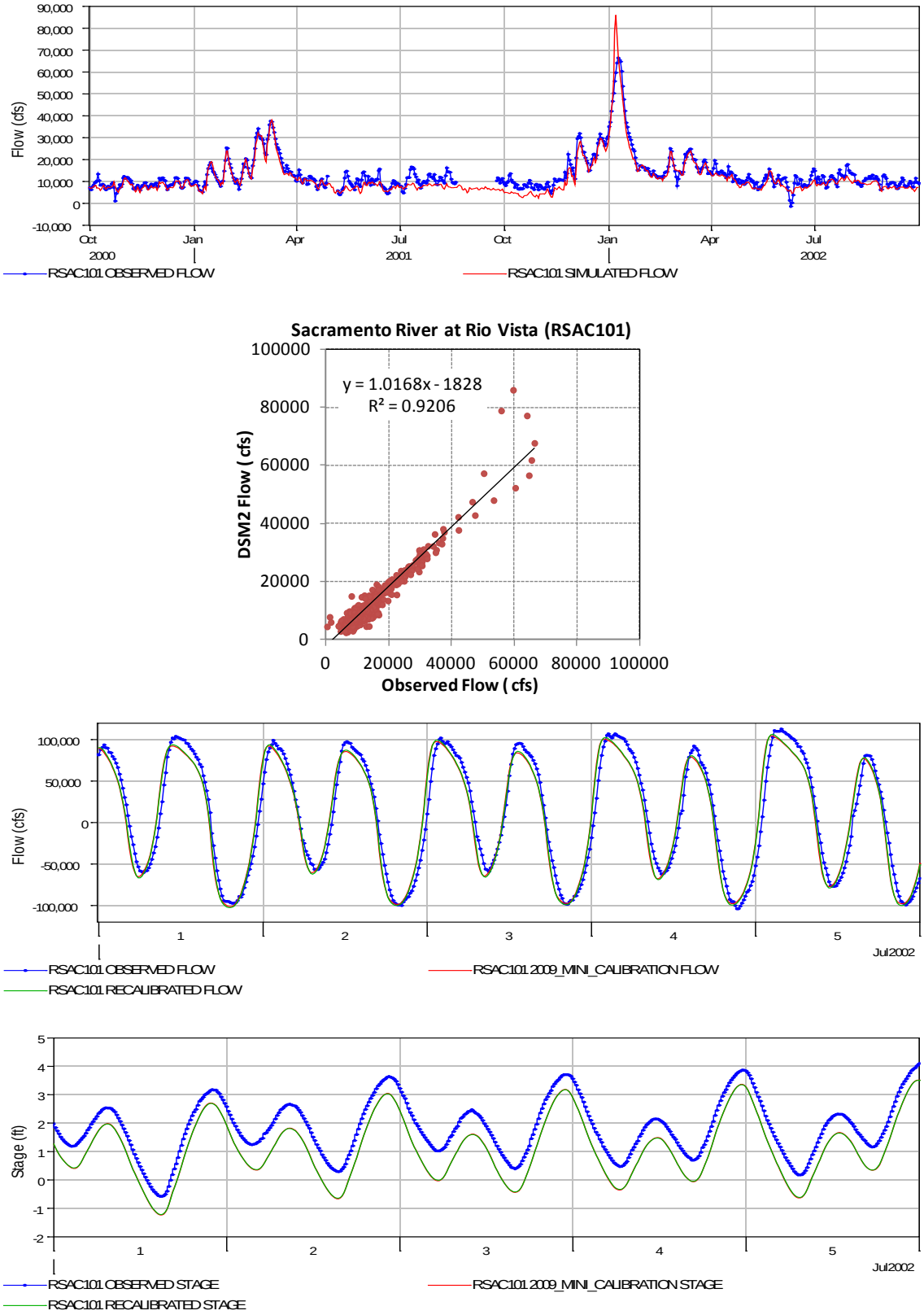


Figure 3-5 Hydro Calibration, Sacramento River at Rio Vista

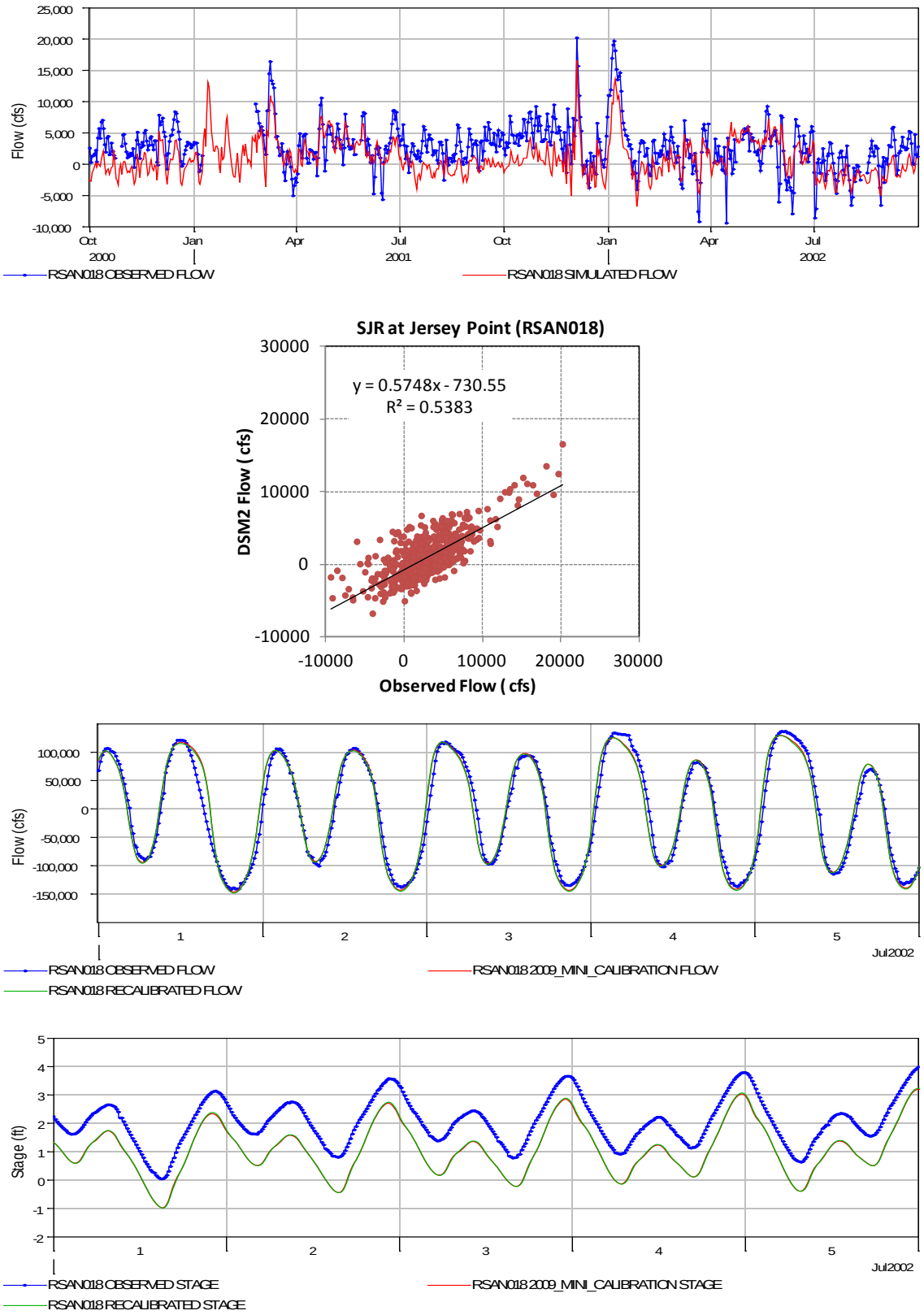


Figure 3-6 Hydro Calibration, San Joaquin River at Jersey Point

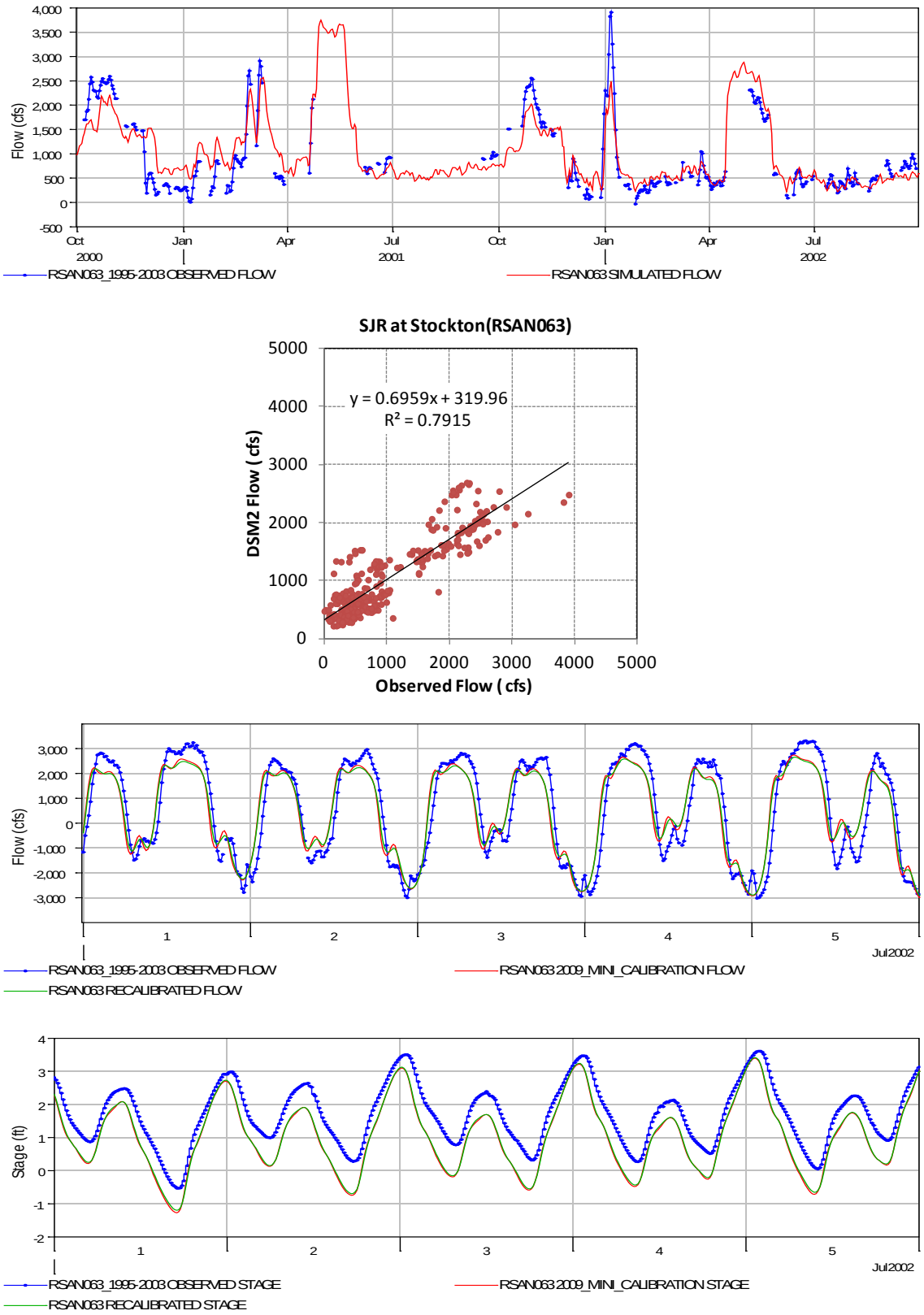
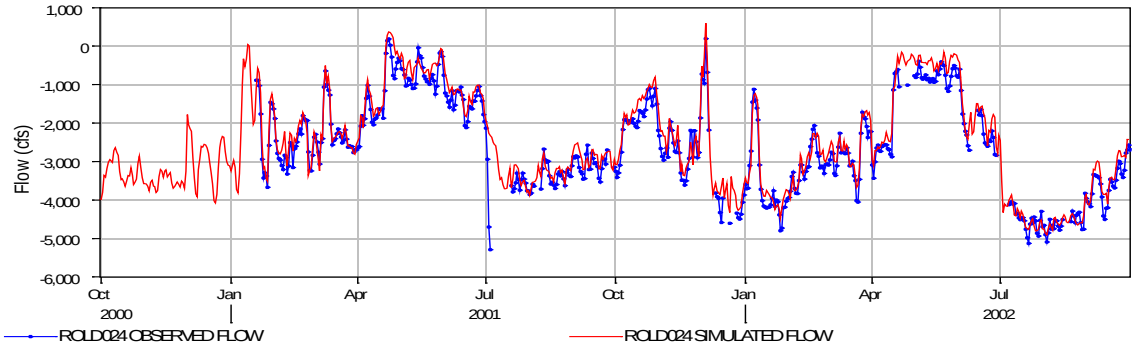
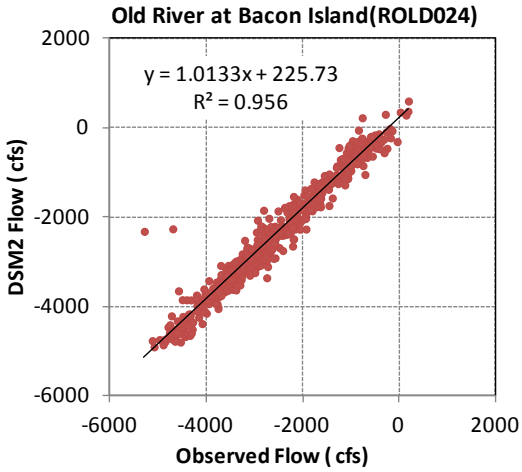
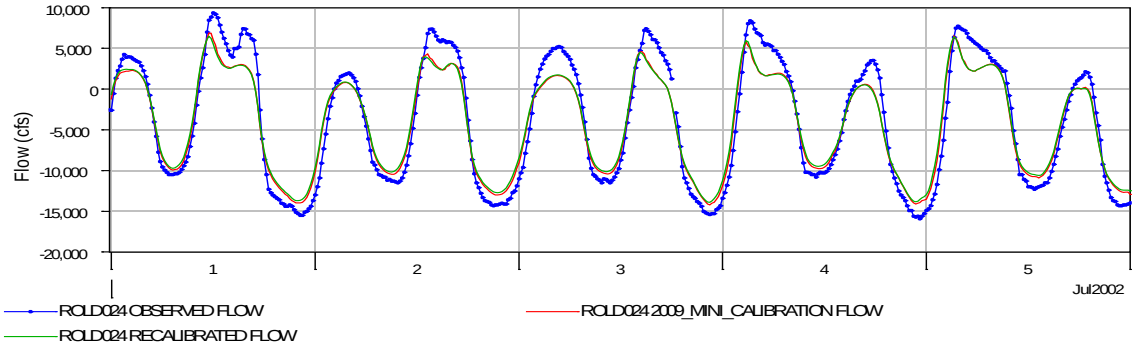


Figure 3-7 Hydro Calibration, San Joaquin River at Stockton







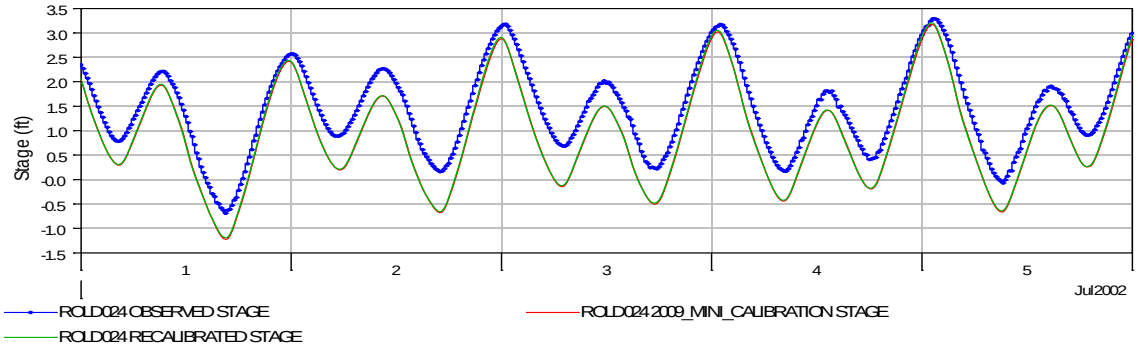


Figure 3-8 Hydro Calibration, Old River at Bacon Island

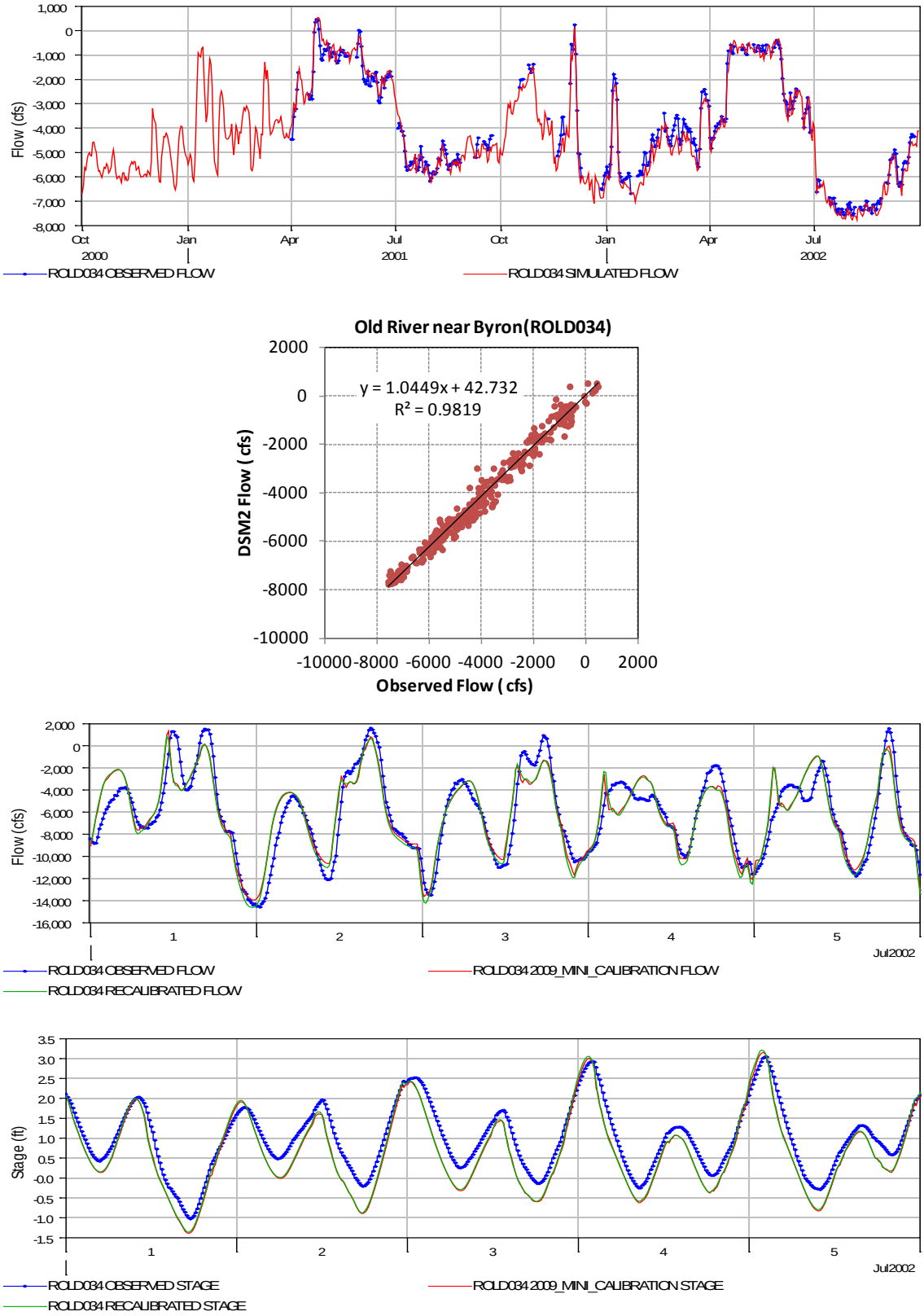


Figure 3-9 Hydro Calibration, Old River near Byron

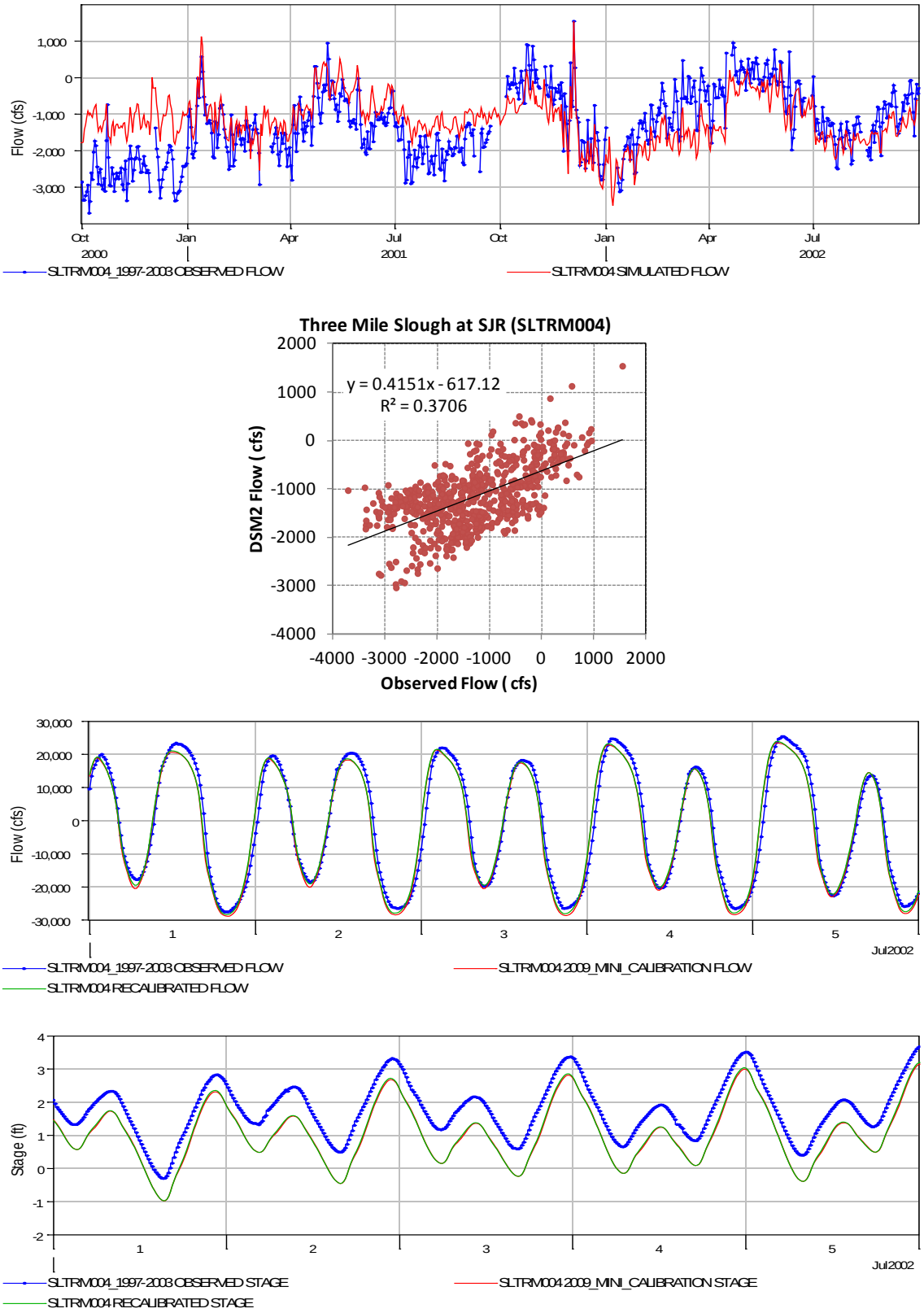


Figure 3-10 Hydro Calibration, Three Mile Slough at SJR

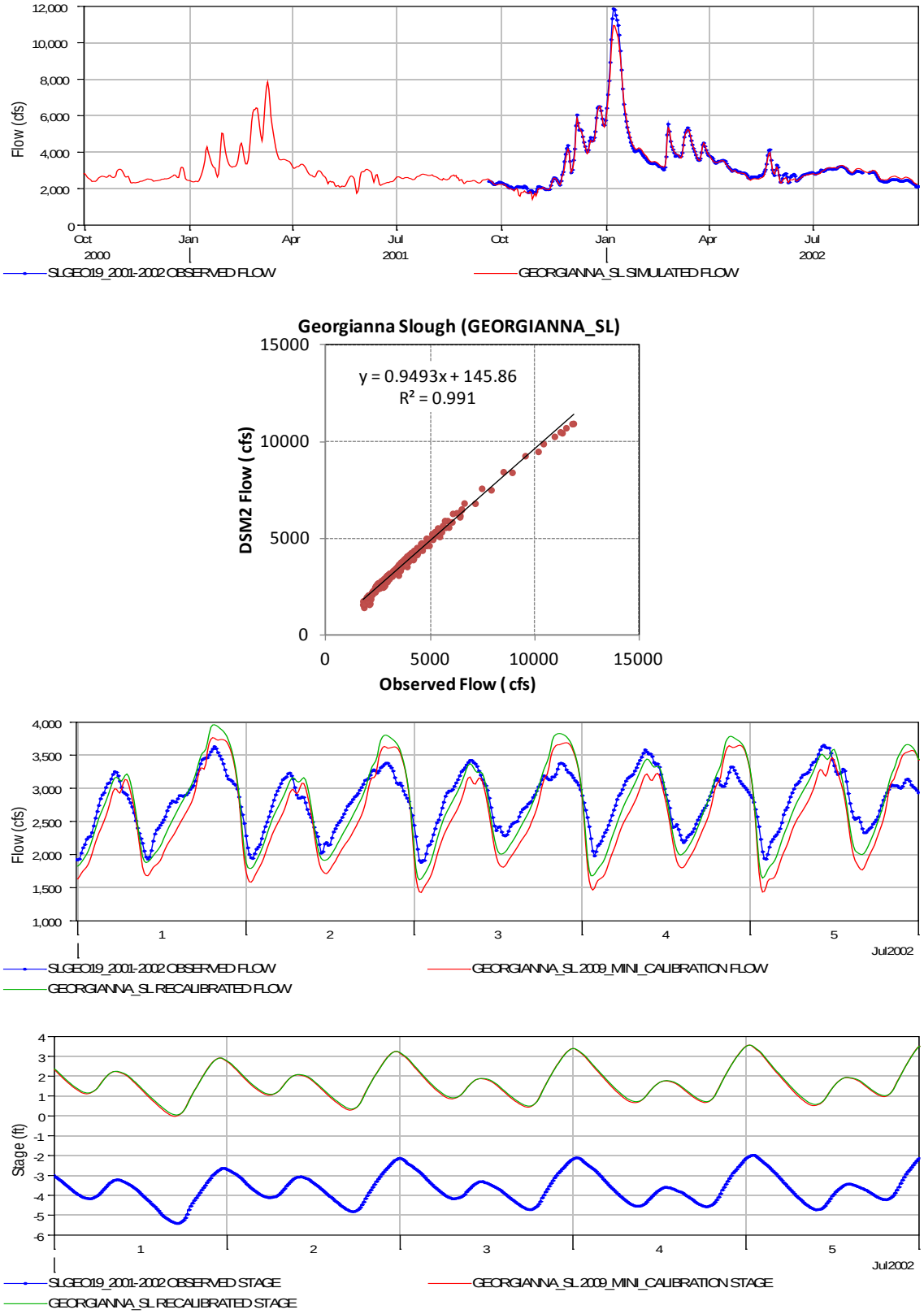
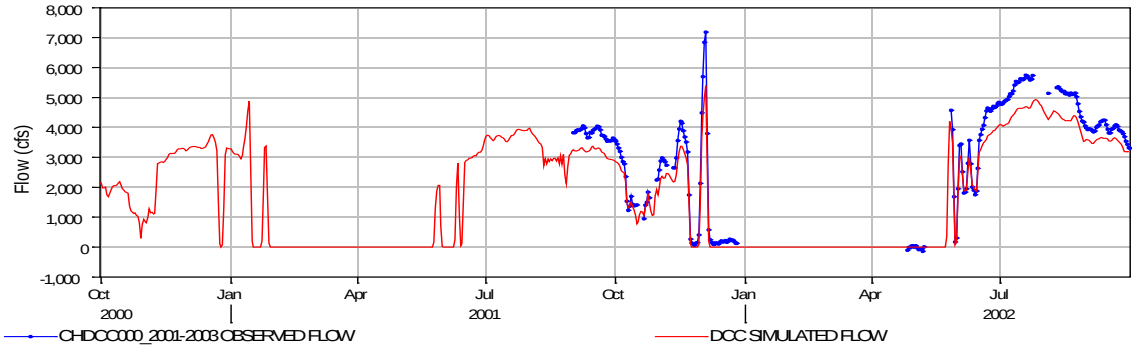
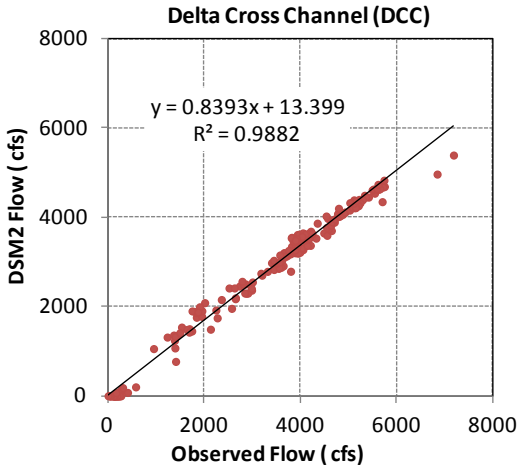
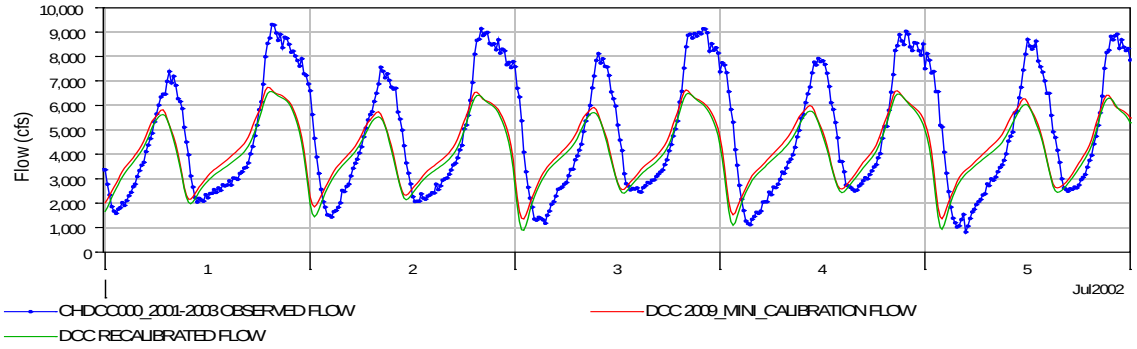


Figure 3-11 Hydro Calibration, Georgiana Slough







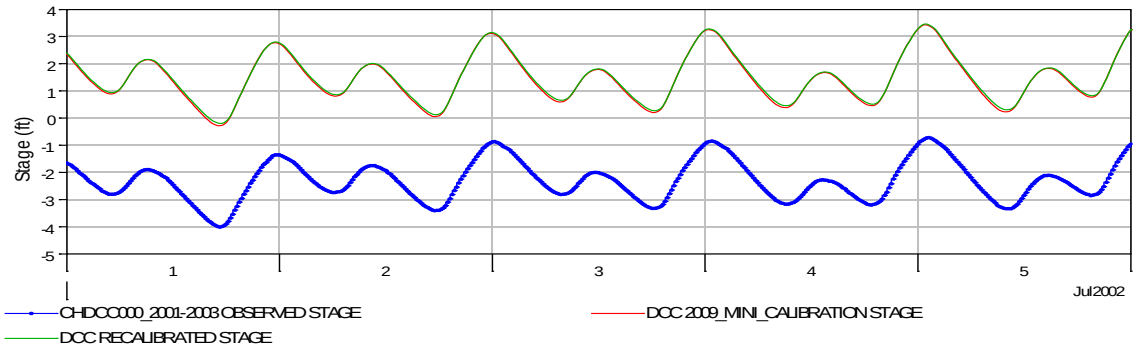


Figure 3-12 Hydro Calibration, Delta Cross Channel

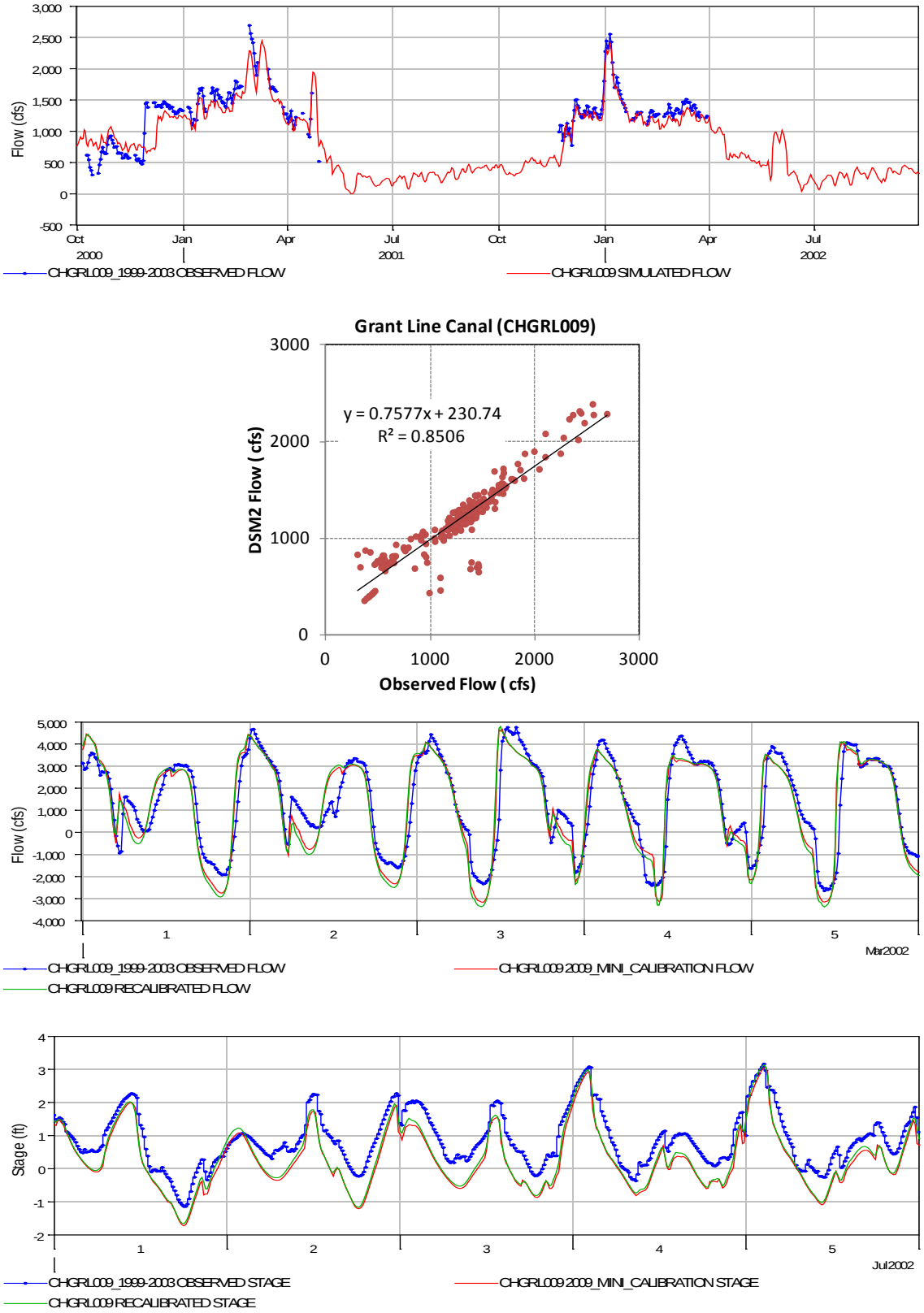


Figure 3-13 Hydro Calibration, Grant Line Canal at Tracy Boulevard Bridge

3.3 EC Recalibration Results

Version 8.1 improved the dispersion formulation to make the model convergent with respect to time step and parcel size, which was described in the 2011 Annual Report (Liu & Ateljevich, 2011) (Liu & Sandhu, 2011). A new dispersion coefficient (DC) was introduced. A limited dispersion recalibration was done and presented in the 2011 DSM2 Users Group newsletter (Liu & Sandhu, 2011 Aug). The calibration was based on the 2009 BDCP Calibration grid by CH2M (CH2M Hill, 2009 Oct). The 2009 calibration by CH2M was done using DSM2 Version 6. The calibration period was from 10/1/2000 to 10/1/2008. The recalibration of version 8.1.1 was done by scaling the previously calibrated dispersion coefficients globally, without fine-tuning, and using the same calibration period. The best result was obtained when new coefficients (DC) were calculated and scaled by 1425, i.e. DC=1425*DQQ. This approach works because the improved dispersion formulation is closely correlated to the original formulation (both versions scaled dispersion with discharge Q).

In this chapter, with the recalibrated Hydro, we reran the previously calibrated Qual model. Key stations are shown in Figure 3-14. The results are presented here at key stations: Collinsville, Emmaton, Jersey Point, Old River at Bacon Island, Clifton Court Forebay, and Montezuma Slough at Beldons Landing (Figure 3-15 to Figure 3-20). The electrical conductivity (EC) results didn't change significantly from the previous calibration. No new adjustments were made.

Three figures are plotted for each station to evaluate the model performance:

- **Linear regression analysis of monthly averaged EC.** This scatterplot with a linear regression trend line shows the simulated vs. observed monthly averaged EC. The intercept is set to zero so that the slope shows the bias of the model for higher EC. The model is over-estimating EC when the slope is higher than 1, and under-estimating EC when the slope is smaller than 1. R2 value gives information about the goodness of fit of the model. A high R2 value close to 1 means best fit, which usually means high quality data and good model prediction.
- **Timeseries comparison of monthly averaged EC.** This plot compares modeled and observed EC month by month, making it easier to see how the model is doing month to month.
- **Timeseries comparison of daily averaged EC.** This plot compares modeled and observed EC on a daily basis, making it easier to see how the model is doing over all.

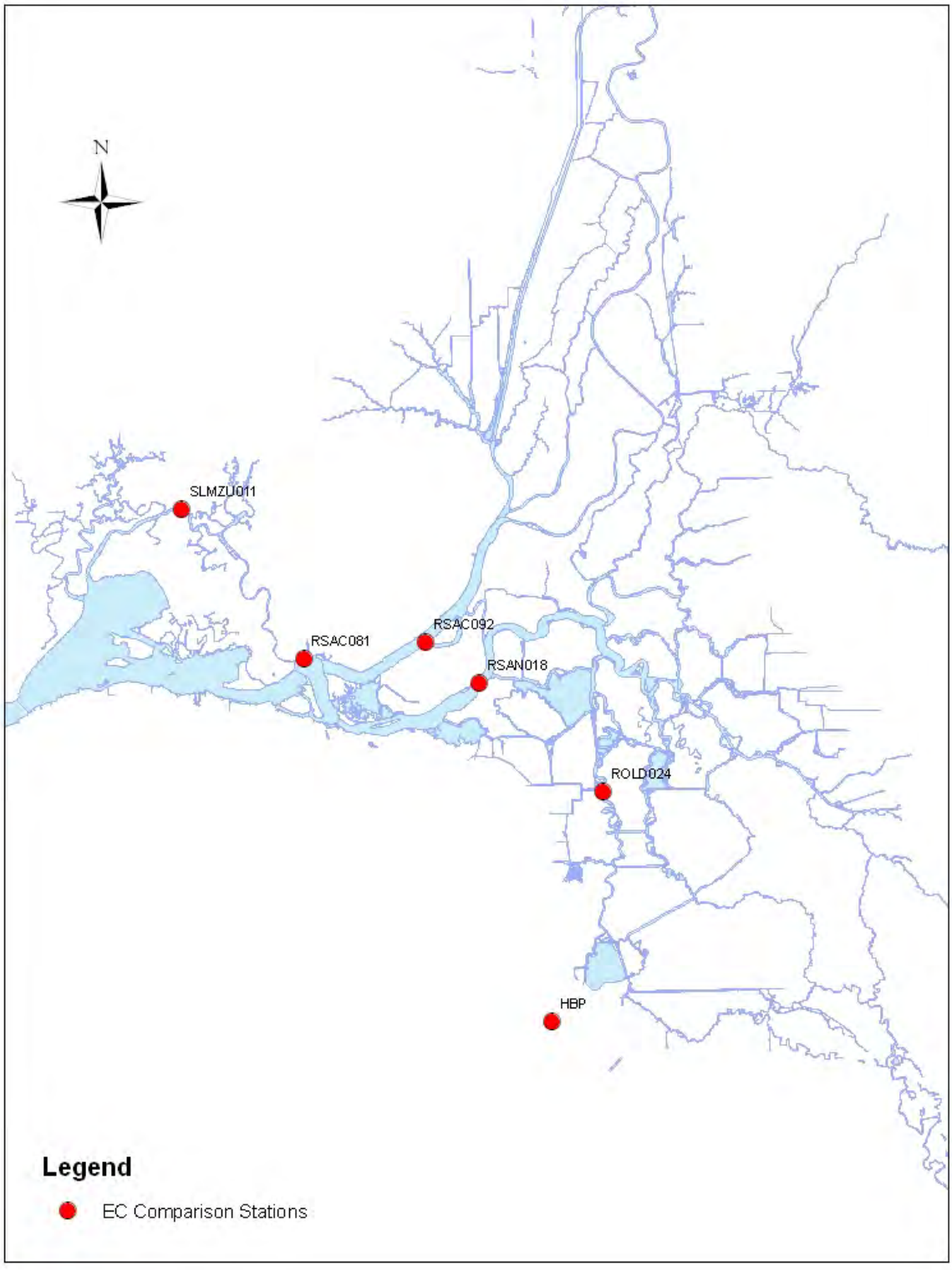


Figure 3-14 Key EC Comparison Stations

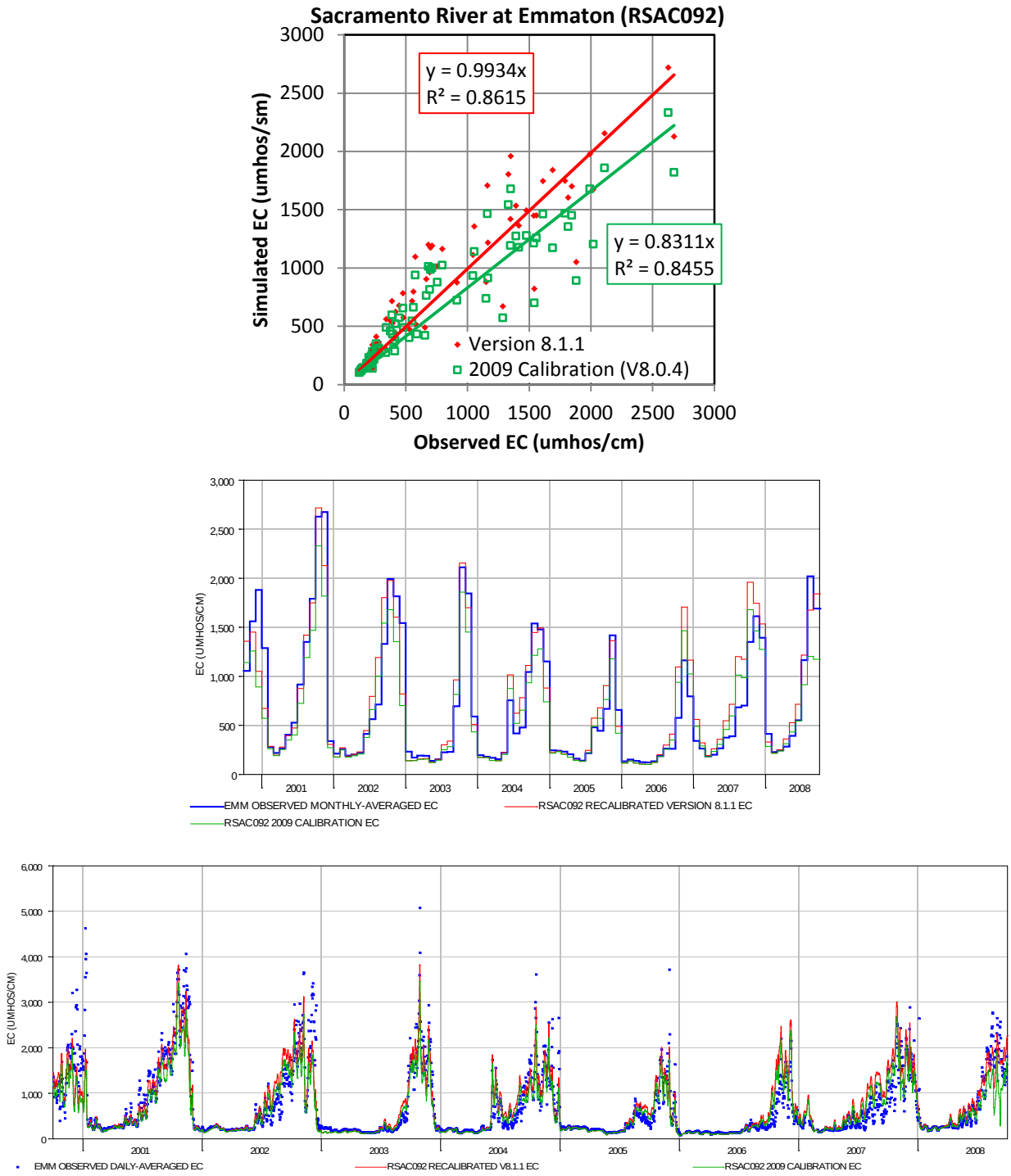


Figure 3-15 Qual Model Performance of EC, Sacramento River at Emmaton

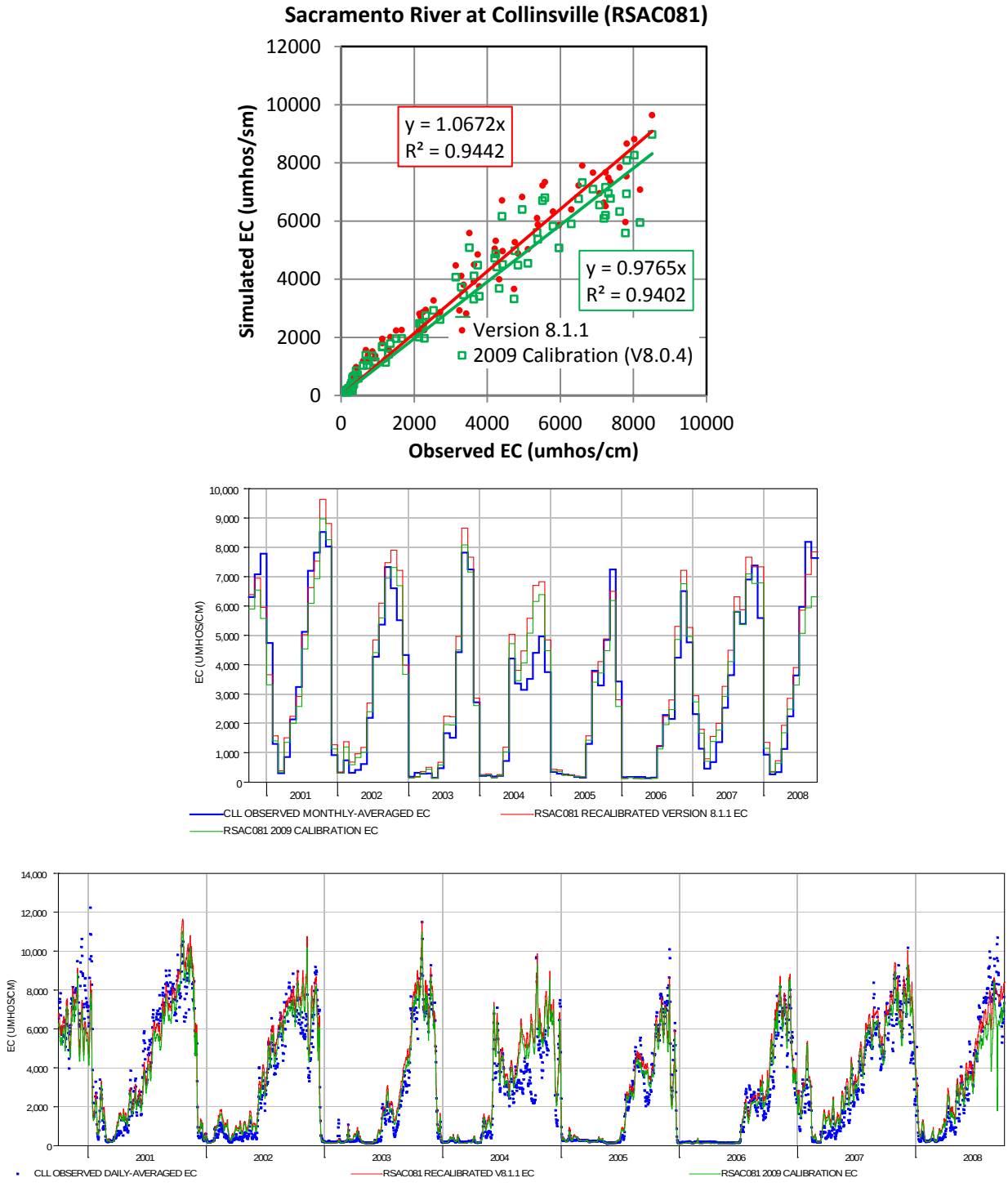


Figure 3-16 Qual Model Performance of EC, Sacramento River at Collinsville

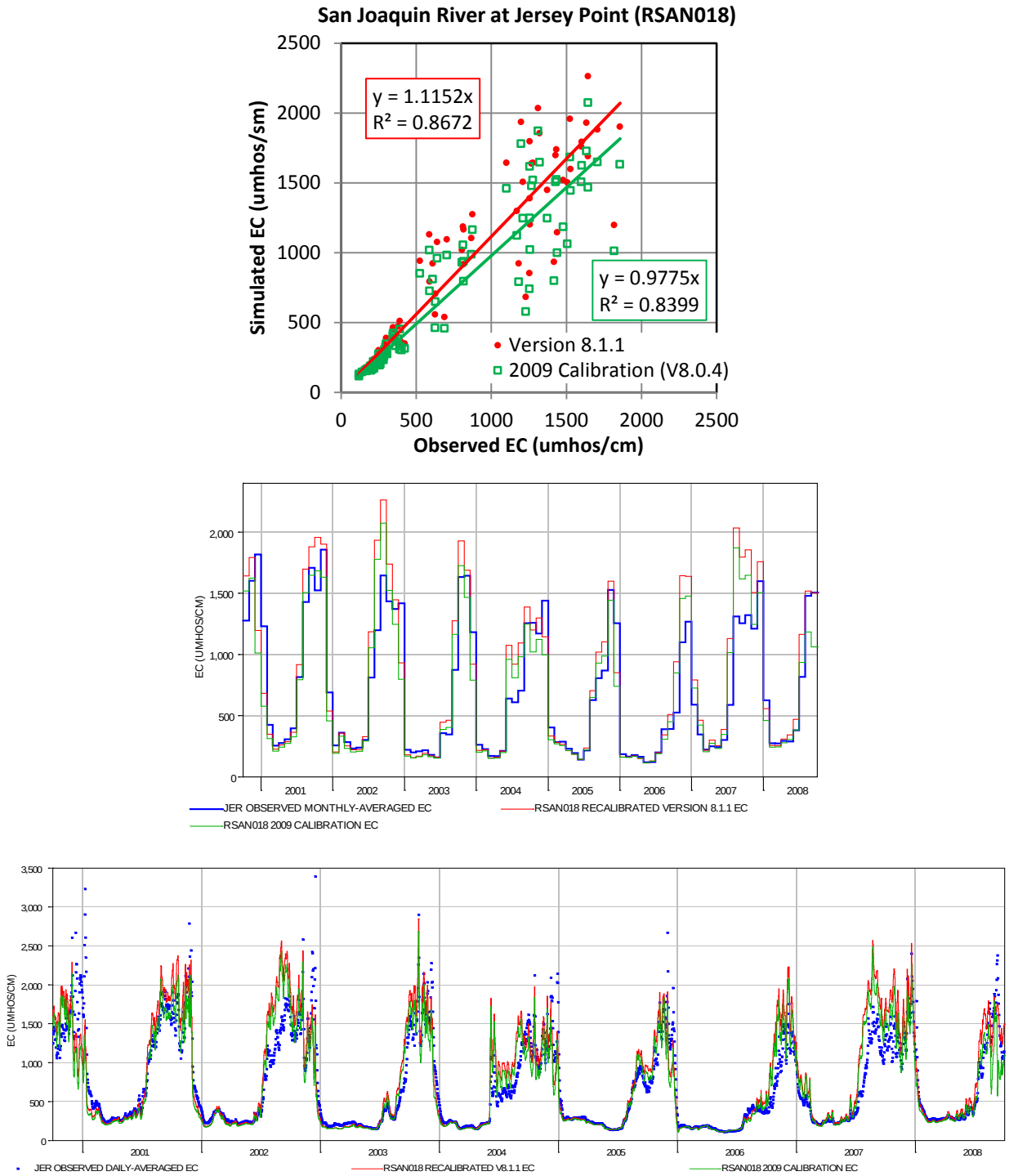


Figure 3-17 Qual Model Performance of EC, San Joaquin River at Jersey Point

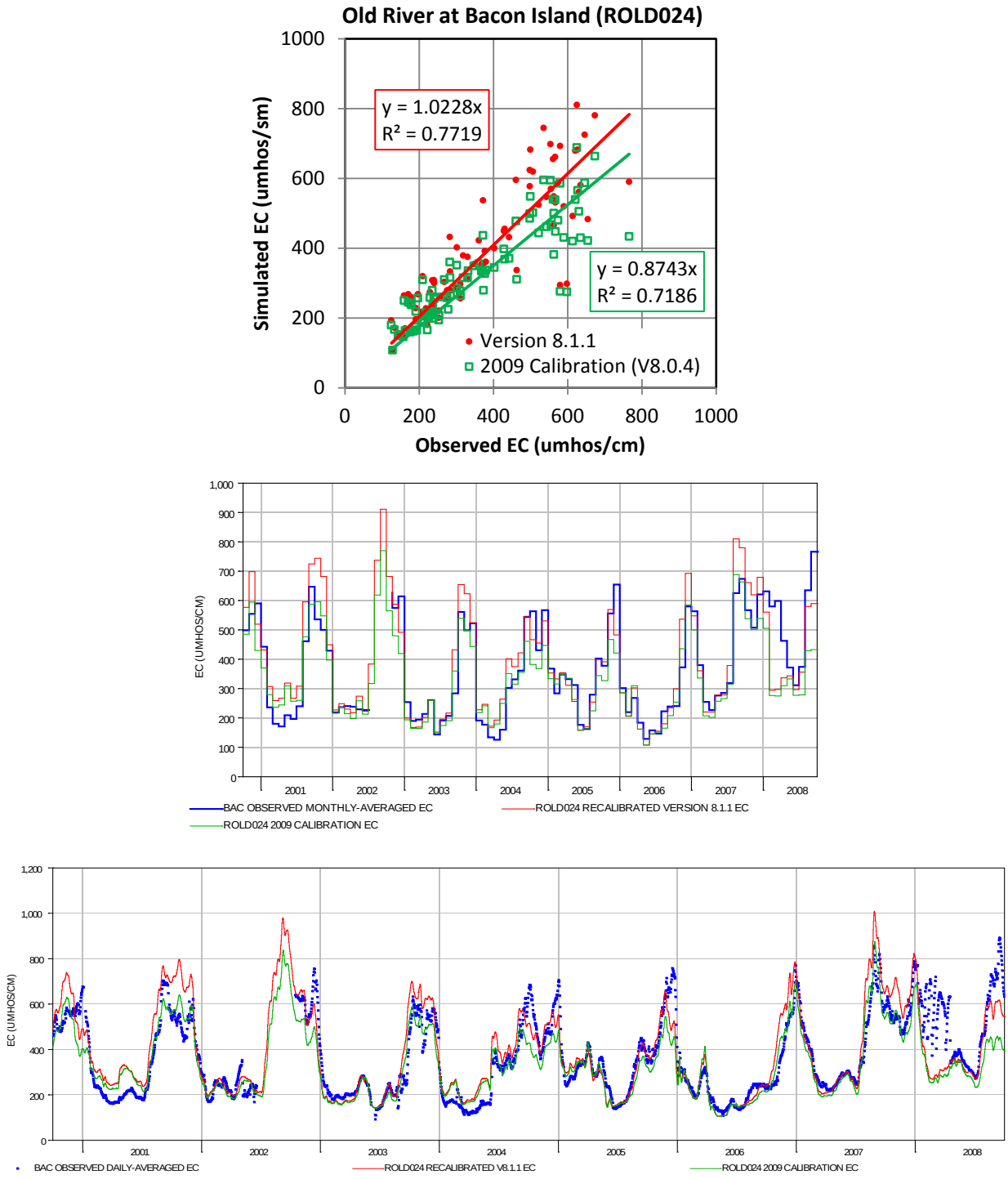


Figure 3-18 Qual Model Performance of EC, Old River at Bacon Island

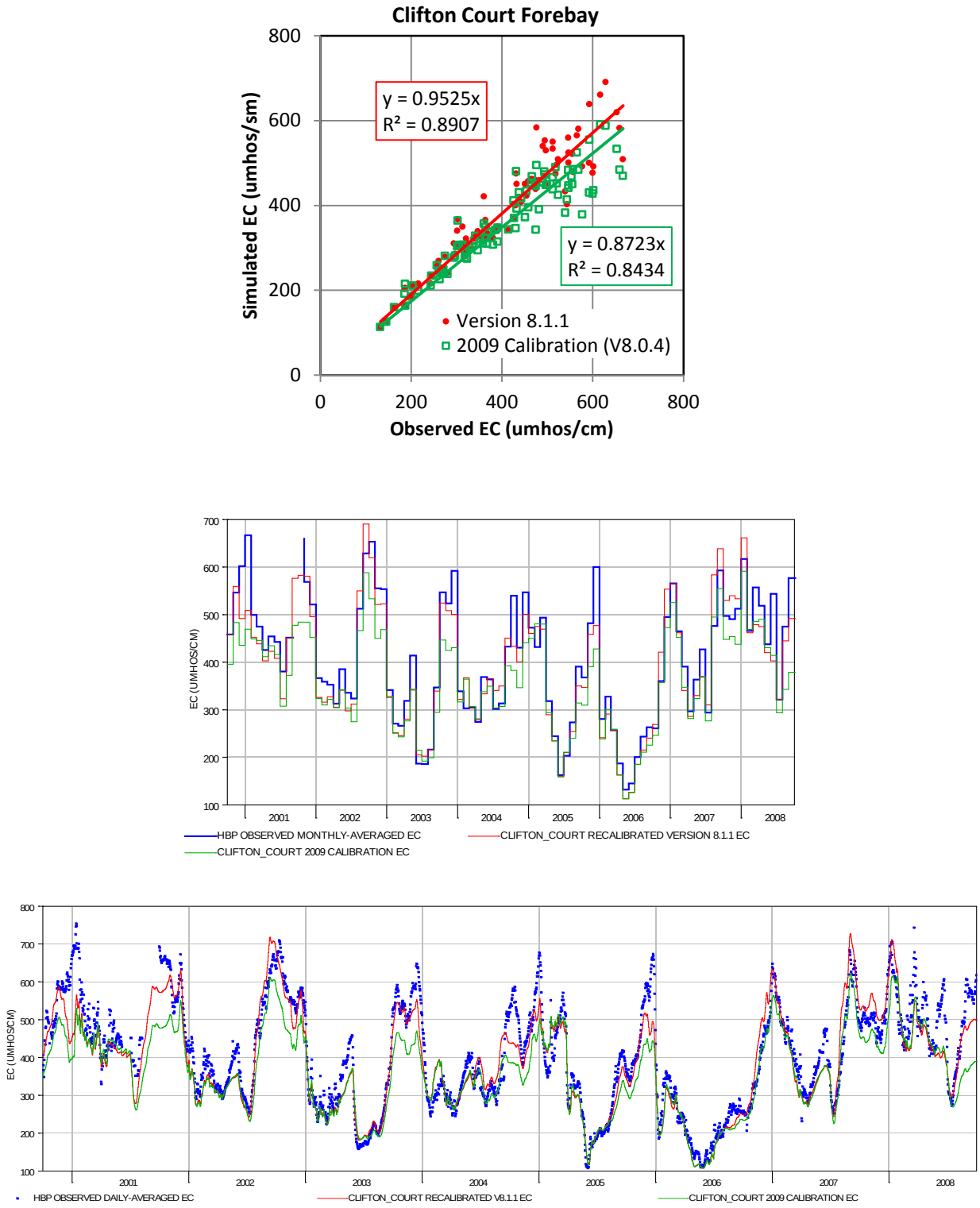


Figure 3-19 Qual Model Performance of EC, Clifton Court Forebay

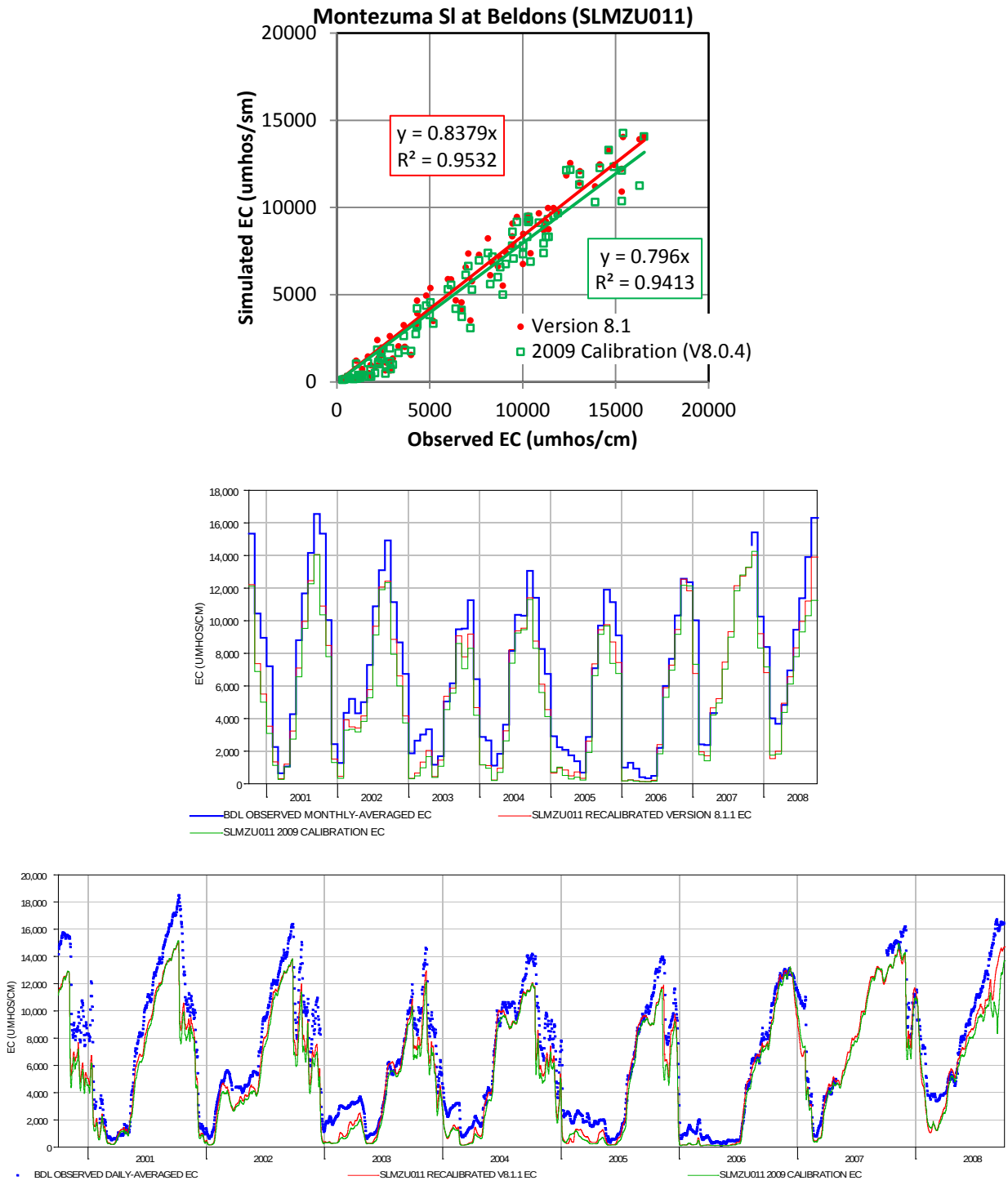


Figure 3-20 Qual Model Performance of EC, Montezuma Slough at Beldons Landing

3.4 Summary

The modifications of channel geometry interpolation and dispersion formulation in Version 8.1 did not result in a significant change in the model results after a brief recalibration. Hydro results are very close to the 2009 calibration, although there are significant changes of Manning's n values. EC results are generally higher than 2009 calibration values. Simulated EC at Clifton Court Forebay matches observed data better than in 2009 calibration.

We are working to improve the calibration by making changes and corrections to the model setup and input. The areas that need improvement and that we have been working on include Martinez EC discrepancy, Delta Cross Channel flow, lower minimum stage than observed at most stations, and Franks Tract representation. We found that NAVD88 is better than NGVD29 when comparing stages at Delta stations. The next improved version of recalibration will use NAVD88. Auto-Calibration will be used to optimize calibration coefficients.

Finally, a full recalibration would involve bigger changes, e.g., improve the channel schematic, regenerate cross sections based on better bathymetry data; improve estimates of diversions, return flows, and return flow water quality; improve Clifton Court gate modeling, etc.

3.5 References

CH2M Hill. (2009 Oct). *DSM2 Recalibration.* Sacramento, CA: Prepared for the California Department of Water Resources.

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